

OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **LAKE WINNISQUAM (Three Island, Pot Island, and Mohawk Island)**, the program coordinators have made the following observations and recommendations.

The **Pot Island** monitoring group sampled the central deep spot and tributaries three times this summer. As this group knows, with multiple sampling events each season, we will be able to more accurately detect changes in water quality. Keep up the good work!

The **Three Island** and **Mohawk Island** monitoring groups sampled the northern and southern deep spots, respectively, once this summer. We thank these groups for sampling **once** this summer. However, we encourage these groups to sample **additional** times each summer. Typically we recommend that monitoring groups sample **three times** per summer (once in **June, July, and August**). We understand that the number of sampling events each group decides to conduct per summer will depend upon volunteer availability, and the monitoring group's water monitoring goals and funding availability. However, with a limited amount of data it is difficult to determine accurate and representative water quality trends. Since weather patterns and activity in the watershed can change throughout the summer, from year to year, and even from hour to hour during a rain event, it is a good idea to sample the lake at least once per month over the course of the season. If either group is having difficulty finding volunteers to help sample, or to pick-up or drop-off equipment at one of the laboratories, please give the VLAP Coordinator a call and we will try to work out an arrangement.

There have been several projects that DES has been involved with along the Lake Winnisquam shoreline and within the watershed. These projects involve Ahern State Park in Laconia and stormwater improvement projects for Maple Circle and Gray Road in Sanbornton.

Ahern State Park, Laconia

On December 10, 2002, Department of Environmental Services (DES) personnel met with the City of Laconia and the Ahern State Park Advisory Committee to discuss the water quality at Ahern State Park Beach. As a result of that meeting, DES developed and carried out a water quality monitoring plan for Ahern State Park, both at the beach

area and in the Governor Park Stream watershed in Summer 2003. The purpose of the monitoring was to identify and quantify sources of *E. coli* bacteria to the beach area.

During the Summer of 2003, DES conducted a sanitary survey of the Governor Park Stream watershed. In addition, DES conducted multiple rounds of dry weather and wet weather sampling. Potential bacteria sources were identified, documented, and mapped.

It was determined that sources of *E. coli* bacteria originating from the Lakes Region Correctional Facility grounds is the probable cause of water quality standard violations at Ahern State Park Beach and in Governor Park Stream during and immediately after stormwater runoff events. The primary suspected source is leakage and exfiltration from old clay sewer pipes.

In 2005, DES, DOC and the Department of Resources and Economic Development (DRED) agreed to a beach advisory plan that allowed beach advisory postings to occur based upon the site-specific relationship of rainfall and bacteria loading at the beach. A rain gage was installed at the DES Air Monitoring Station located at the DOC Lakes Region Facility. Following a 0.25 inch rainfall event, an email notification was automatically generated and distributed to DES, DOC, and DRED. Beach advisories were then posted by DRED at the site and by DES on the Beach Program website. Approximately 20 beach advisories were posted from May 1 through September 30, 2005.

In April 2005, the U.S. Environmental Protection Agency (EPA) issued an Administrative Order (AO) to DOC for the discharge of pollutants to Governor Park Stream without a National Pollution Discharge Elimination System (NPDES) permit. The AO required DOC to develop and implement an EPA-approved plan for identifying and eliminating the sources of unauthorized pollutants that discharge into Governor Park Stream. DOC hired Hoyle, Tanner and Associates, Inc. (HTA) to assist with fulfilling the requirements of the AO. HTA completed their investigation and issued a summary report in November, 2005 which recommended additional sampling and testing, to determine the origin source of the bacteria and several sanitary and storm water system repairs.

In 2006, HTA and DES conducted several rounds of additional stormwater testing, as required by EPA's AO. The additional testing focused on distinguishing between overland or subsurface bacteria loads using stormwater simulation events and EPA's Illicit Discharge, Detection and Elimination (IDDE) protocol.

The HTA draft report dated September 27, 2006, specifies that the most recent testing along with supporting evidence from the closed circuit television inspection, dye flood testing and smoke testing of the sanitary and stormwater system, indicates that the primary contributor of *E. coli*

bacteria to the DOC stormwater system originates from wildlife populations within the subwatershed associated with the subsurface stormwater system. *E. coli* bacteria is picked up and transported by overland stormwater flow to the subsurface stormwater system where it discharges to Governor Park Stream and eventually Lake Winnisquam.

An EPA review of the above findings has not occurred as of the writing of this report. A preliminary evaluation based upon *E. coli* bacteria originating from wildlife may include stormwater improvements, promoting stormwater infiltration, eliminating the bacteria source from entering the stormwater system.

Maple Circle and Gray Road, Sanbornton

During 2005 and 2006, several storm events resulted in ditch line and road washouts, causing sediment to be deposited into Lake Winnisquam. Beyond the negative impacts to water quality related to the physical aspect of sediment deposition, sediment can transport phosphorus and other pollutants to Lake Winnisquam.

The Town of Sanbornton recognized the impact of these storm events to its residents and Lake Winnisquam. As a result, the Town temporarily installed a sediment barrier in the lake to retain the deposited sediment, hired a contractor to remove the sediment during the October 2006 drawdown conditions and hired an engineer to perform a stormwater analysis for the Black Brook subwatershed that includes Maple Circle and Gray Road.

The sediment barrier was successfully installed by the Town Department of Public Works and approximately 100 yards of sediment deposited at the Maple Circle beach was efficiently removed from the Lake.

In October, 2006, Paul Fluet of Fluet Engineering was hired by the Town to perform the stormwater analysis. The Town received the draft comprehensive drainage report in December 2006. The Town of Sanbornton, Fluet Engineering, and DES will be meeting to discuss an implementation plan in 2007.

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** Figure 1 in Appendix A shows the historical and current year chlorophyll-a concentration in the water column. Table 1 in Appendix B lists the maximum, minimum, and mean concentration for each sampling year that the lake has been monitored through VLAP.

Chlorophyll-a, a pigment found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m³.**

THREE ISLAND DEEP SPOT

The current year data (the top graph) show that the chlorophyll-a concentration on the **September** sampling event was *less than* the state median and was *greater than* the similar lake median. For more information on the similar lake median, refer to Appendix F.

Visual inspection of the historical data trend line (the bottom graph) shows a *variable, but overall slightly increasing, meaning slightly worsening*, in-lake chlorophyll-a trend since monitoring began in **1987**.

Please keep in mind that this trend is based on limited data. As your group expands its sampling program to include additional events each year, we will be able to determine trends with more accuracy and confidence.

After 10 consecutive years of sample collection at this deep spot, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

POT ISLAND DEEP SPOT

The current year data (the top graph) show that the chlorophyll-a concentration *increased slightly* from **July** to **August**, and then *decreased slightly* from **August** to **September**.

The historical data (the bottom graph) show that the **2006** chlorophyll-a mean is *less than* the state median and is *greater than* the similar lake median. For more information on the similar lake median, refer to Appendix F.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a **variable** in-lake chlorophyll-a trend. Specifically, the mean chlorophyll concentration has **fluctuated between approximately 1.15 and 3.88 mg/m³** since **1987**.

In the **2007** biennial annual report, since this deep spot will have been sampled for at least **ten** consecutive years for chlorophyll, we will conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began. Please refer to Appendix E for a detailed statistical analysis explanation.

MOHAWK ISLAND DEEP SPOT

The current year data (the top graph) show that the chlorophyll-a concentration on the **July** sampling event was **greater than** the state median and the similar lake median. For more information on the similar lake median, refer to Appendix F.

Visual inspection of the historical data trend line (the bottom graph) shows a **variable, but overall increasing, meaning worsening**, in-lake chlorophyll-a trend since monitoring began in **1987**.

Please keep in mind that this trend is based on limited data. As your group expands its sampling program to include additional events each year, we will be able to determine trends with more accuracy and confidence.

After 10 consecutive years of sample collection at this deep spot, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

While algae are naturally present in all lakes, an excessive or increasing amount of any type is not welcomed. In freshwater lakes, phosphorus is the nutrient that algae typically depend upon for growth in New Hampshire lakes. Algal concentrations may increase as nonpoint sources of phosphorus from the watershed increase, or as in-lake phosphorus sources increase. Therefore, it is extremely important for volunteer monitors to continually educate all watershed residents about management practices that can be implemented to minimize phosphorus loading to surface waters.

- **Figures 2a and 2b and Tables 3a and 3b:** Figure 2a in Appendix A shows the historical and current year data for transparency without the use of a viewscope and Figure 2b shows the current year data for transparency with the use of a viewscope. Table 3a in Appendix B lists the maximum, minimum and mean transparency data without the use of a viewscope and Table 3b lists the maximum, minimum and mean transparency data with the use of a viewscope for each year that the lake has been monitored through VLAP.

Volunteer monitors use the Secchi disk, a 20 cm disk with alternating black and white quadrants, to measure how far a person can see into the water. Transparency, a measure of water clarity, can be affected by the amount of algae and sediment in the water, as well as the natural color of the water. **The median summer transparency for New Hampshire's lakes and ponds is 3.2 meters.**

THREE ISLAND DEEP SPOT

The current year data (the top graph) show that the non-viewscope in-lake transparency on the **September** sampling event was **greater than** the state median and was **much less than** the similar lake median. Please refer to Appendix F for more information about the similar lake median.

In addition, the non-viewscope transparency on the **September** sampling event was the **shallowest (meaning least-deep)** transparency reading that has been measured at this deep spot since monitoring began.

The viewscope in-lake transparency was **much greater than** the non-viewscope transparency on the **September** sampling event. As discussed previously, a comparison of transparency readings taken with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. We recommend that your group measure Secchi disk transparency with and without the viewscope on each sampling event.

It is important to note that viewscope transparency data are not compared to a New Hampshire median or similar lake median. This is because lake transparency has not been historically measured by DES with a viewscope. At some point in the future, the New Hampshire and similar lake medians for viewscope transparency will be calculated and added to the appropriate graphs.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a **variable** trend for in-lake non-viewscope transparency. Specifically, the transparency has **fluctuated between approximately 4.75 and 10.5 meters** since monitoring began in **1987**.

Please keep in mind that this trend is based on limited data. As your group expands its sampling program to include additional events each year, we will be able to determine trends with more accuracy and confidence.

As previously discussed, after 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

POT ISLAND DEEP SPOT

The current year data (the top graph) show that the non-viewscope in-lake transparency **remained stable** from **July to August**, and then **increased** from **August to September**.

The historical data (the bottom graph) show that the **2006** mean non-viewscope transparency is **much greater than** the state median and is **slightly less than** the similar lake median. Please refer to Appendix F for more information about the similar lake median. The **2006** annual mean ties the **1990** annual mean as being the **shallowest (meaning least-deep)** annual mean since monitoring began at this deep spot.

The viewscope in-lake transparency was **greater than** the non-viewscope transparency on the **August** and **September** sampling events. The transparency was not measured with the viewscope on the **July** sampling event at this deep spot. We recommend that each group measure Secchi disk transparency with and without the viewscope on each sampling event.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a **slightly variable** trend for in-lake non-viewscope transparency. Specifically, the transparency has **fluctuated between approximately 7.33 and 9.08 meters** since monitoring began in **1987**.

In the **2007** biennial annual report, since this deep spot will have been sampled for at least **ten** consecutive years for transparency, we will conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began. Please refer to Appendix E for a detailed statistical analysis explanation.

MOHAWK ISLAND DEEP SPOT

The current year data (the top graph) show that the non-viewscope in-lake transparency on the **July** sampling event was **greater than** the state median and was **less than** the similar lake median. Please refer to Appendix F for more information about the similar lake median.

The viewscope in-lake transparency was **greater than** the non-viewscope transparency on the **July** sampling event.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a **variable** trend for in-lake non-viewscope transparency. Specifically, the transparency has **fluctuated between approximately 5.10 and 7.90 meters** since monitoring began in **1987**.

Please keep in mind that this trend is based on limited data. As your group expands its sampling program to include additional events each year, we will be able to determine trends with more accuracy and confidence.

As previously discussed, after 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

Typically, high intensity rainfall causes sediment-laden stormwater runoff to flow into surface waters, thus increasing turbidity and decreasing clarity. Efforts should continually be made to stabilize stream banks, lake shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake. Guides to best management practices that can be implemented to reduce, and possibly even eliminate, nonpoint source pollutants, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 in Appendix A show the amount of epilimnetic (upper layer) phosphorus and hypolimnetic (lower layer) phosphorus; the inset graphs show current year data. Table 8 in Appendix B lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake has been sampled through VLAP.

Phosphorus is typically the limiting nutrient for plant and algae growth in New Hampshire's lakes and ponds. Excessive phosphorus in a lake can lead to increased plant and algal growth over time. **The median summer total phosphorus concentration in the**

epilimnion (upper layer) of New Hampshire's lakes and ponds is 12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.

THREE ISLAND DEEP SPOT

The current year data for the epilimnion (the top inset graph) and the hypolimnion (the bottom inset graph) show that the phosphorus concentration on the **September** sampling event was *less than* the state median and was *approximately equal to* the similar lake median. Refer to Appendix F for more information about the similar lake median.

Overall, visual inspection of the historical data trend line for the epilimnion and hypolimnion shows a *variable* phosphorus trend since monitoring began. Specifically, the mean annual epilimnetic phosphorus concentration has *fluctuated between approximately 2.0 and 13.0 ug/L*, and the mean annual hypolimnetic phosphorus concentration has *fluctuated between approximately 7.0 and 18.0 ug/L*, since monitoring began in **1987**.

Please keep in mind that these trends are based on limited data. As your group expands its sampling program to include additional events each year, we will be able to determine trends with more accuracy and confidence.

As discussed previously, after 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean phosphorus concentration since monitoring began.

POT ISLAND DEEP SPOT

The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration *decreased gradually* from **July** to **September**.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration *decreased slightly* from **July** to **August** and then *increased* from **August** to **September**.

The historical data show that the **2006** mean epilimnetic and hypolimnetic phosphorus concentrations are *less than* the state median and are *slightly greater than* the similar lake median. Please refer to Appendix F for more information about the similar lake median.

Overall, visual inspection of the historical data trend line for the epilimnion and hypolimnion shows a ***slightly variable*** phosphorus trend. Specifically, the mean annual epilimnetic phosphorus concentration has ***fluctuated between approximately 4.0 and 9.0 ug/L***, and the mean annual hypolimnetic phosphorus concentration has ***fluctuated between approximately 5.0 and 15.5 ug/L***, since monitoring began in **1987**.

As discussed previously, in the **2007** biennial annual report, since this deep spot will have been sampled for phosphorus for at least **ten** consecutive years, we will conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean phosphorus concentration since monitoring began.

MOHAWK ISLAND DEEP SPOT

The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration on the **July** sampling event was ***less than*** the state median and is ***greater than*** the similar lake median. Refer to Appendix F for more information about the similar lake median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration on the **July** sampling event was ***greater than*** the state median and similar lake median.

The turbidity of the hypolimnion (lower layer) sample was ***elevated*** on the **July** sampling event (**2.14 NTUs**). In addition, the hypolimnetic turbidity has ***been at least slightly elevated*** on many sampling events during previous years. This suggests that the lake bottom in this area is covered by a thick organic layer of sediment which is easily disturbed. When the lake bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

Overall, visual inspection of the historical data trend line for the epilimnion shows a ***variable*** phosphorus trend. Specifically, the mean annual epilimnetic phosphorus concentration has ***fluctuated between approximately 1.0 and 12.5 ug/L*** since monitoring began in **1987**.

Overall, visual inspection of the historical data trend line for the hypolimnion shows a ***highly variable*** phosphorus trend since monitoring began. Specifically, the mean annual concentration has

fluctuated between approximately 9.0 and 83.0 ug/L since monitoring began in **1987**.

Please keep in mind that these trends are based on limited data. As your group expands its sampling program to include additional events each year, we will be able to determine trends with more accuracy and confidence.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about the sources of phosphorus in a watershed and how excessive phosphorus loading can negatively affect the ecology and the recreational, economical, and ecological value of lakes and ponds.

TABLE INTERPRETATION

➤ **Table 2: Phytoplankton**

Table 2 in Appendix B lists the current and historical phytoplankton species observed in the lake. Specifically, this table lists the three most dominant phytoplankton species observed in the sample and their relative abundance in the sample.

Three Island Deep Spot

The dominant phytoplankton species observed in the **September** sample were ***Tabellaria* (diatom)**, ***Aphanizomenon* (cyanobacteria)**, and ***Chrysosphaerella* (golden-brown)**.

Pot Island Deep Spot

The dominant phytoplankton species observed in the **September** sample were ***Tabellaria* (diatom)**, ***Chrysosphaerella* (golden-brown)**, and ***Aphanizomenon* (cyanobacteria)**.

Mohawk Island Deep Spot

The dominant phytoplankton species observed in the **July** sample were ***Dinobryon* (golden-brown)**, ***Oscillatoria* (cyanobacteria)**, and ***Tabellaria* (diatom)**.

Phytoplankton populations undergo a natural succession during the growing year. Please refer to the “Biological Monitoring Parameters” section of this report for a more detailed explanation regarding yearly plankton succession. Diatoms and golden-brown algae are typical in New Hampshire’s less productive lakes and ponds.

➤ **Table 2: Cyanobacteria**

The cyanobacterium ***Oscillatoria*** was the **second-most** dominant species in the **Mohawk Island** deep spot sample on the **July** sampling event.

The cyanobacterium ***Aphanizomenon*** was the **second-most** dominant species in the **Three Island** deep spot plankton sample and was the **third-most** dominant species in the **Pot Island** deep spot plankton sample on the **September** sampling event.

In addition, a small amount of the cyanobacterium ***Anabaena*** was observed in the **Three Island** and **Pot Island** plankton samples in **September**.

These species, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans. Please refer to the “Biological Monitoring Parameters” section of this report for a more detailed explanation regarding cyanobacteria.

Cyanobacteria can reach nuisance levels when phosphorus loading from the watershed to surface waters is increased and favorable environmental conditions occur, such as a period of sunny, warm weather.

The presence of cyanobacteria serves as a reminder of the lake’s delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading to the lake by eliminating fertilizer use on lawns, keeping the lake shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the lake in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to “pile” cyanobacteria into scums that accumulate in one section of the lake. If a fall bloom occurs, please collect a sample in any clean jar or bottle and contact the VLAP Coordinator.

➤ **Table 4: pH**

Table 4 in Appendix B presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 typically limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. The median pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.6**, which indicates that the surface waters in the state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

The pH at the deep spot this season ranged from **6.31** in the hypolimnion to **6.61** in the epilimnion at the **Three Island** deep spot, from **6.52** in the hypolimnion to **6.88** in the epilimnion at the **Pot Island** deep spot, and from **6.34** in the hypolimnion to **7.06** in the epilimnion at the **Mohawk Island** deep spot. This data indicates that the water is *slightly acidic* near the lake bottom and *approximately neutral* near the lake surface.

It is important to point out that the pH in the hypolimnion (lower layer) was *lower (more acidic)* than in the epilimnion (upper layer). This increase in acidity near the lake bottom is likely due to the decomposition of organic matter and the release of acidic by-products into the water column.

Due to the presence of granite bedrock in the state and acid deposition received from snowmelt, rainfall, and atmospheric particulates, there is not much that can be feasibly done to effectively increase lake pH.

➤ **Table 5: Acid Neutralizing Capacity**

Table 5 in Appendix B presents the current year and historical epilimnetic ANC for each year the lake has been monitored through VLAP.

Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The median ANC value for New Hampshire's lakes and ponds is **4.9 mg/L**, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs. For a more detailed explanation about ANC, please refer to the "Chemical Monitoring Parameters" section of this report.

The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) at the three deep spots ranged from **6.2** to **7.5 mg/L** this year, which is **greater than** the state median. In addition, this indicates that the lake is **moderately vulnerable** to acidic inputs (such as acid precipitation).

➤ **Table 6: Conductivity**

Table 6 in Appendix B presents the current and historical conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current, which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column. The median conductivity value for New Hampshire's lakes and ponds is **40.0 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The epilimnetic conductivity at the **Three Island** deep spot was **80.96 uMhos/cm**, at the **Pot Island** deep spot was **78.48 uMhos/cm**, and at the **Mohawk Island** deep spot was **80.13 uMhos/cm**, all of which are **greater than** the state mean.

The **2006** conductivity results for the deep spots and tributaries were **lower than** has been measured **during the past few years**. It is likely that the high water levels during **2006** diluted the ion concentration in surface waters throughout the watershed. Specifically, the unusually large amount of watershed runoff from the significant late spring rain events likely exceeded the amount of groundwater contribution to the tributaries and lake. In addition, any winter contribution of chloride to surface waters from road salt was likely flushed out of the tributaries and the lake before the lake stratified during the summer.

The conductivity has **increased** in the lake and the inlet tributaries since monitoring began. Typically, increasing conductivity indicates the influence of pollutant sources associated with human activities. These sources include failed or marginally functioning septic systems, agricultural runoff, and road runoff which contains road salt during the spring snow-melt. New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could also contribute to increasing conductivity. In addition, natural sources, such as iron and manganese deposits in bedrock, can influence conductivity.

We also recommend that your monitoring group conduct a shoreline conductivity survey of the lake and the tributaries with **elevated** conductivity to help identify the sources of conductivity.

To learn how to conduct a shoreline or tributary conductivity survey, please refer to the 2004 special topic article, which is posted on the VLAP website at http://www.des.nh.gov/wmb/vlap/2004/documents/Appendix_D.pdf or contact the VLAP Coordinator.

It is possible that de-icing materials applied to nearby roadways during the winter months may be influencing the conductivity in the lake. In New Hampshire, the most commonly used de-icing material is salt (sodium chloride).

Therefore, we recommend that the **epilimnion** at each deep spot and the **tributaries** be sampled for chloride next year. This additional sampling may help us identify what areas of the watershed are contributing to the increasing in-lake conductivity.

Please note that there will be an additional cost for each of the chloride samples and that these samples must be analyzed at the DES laboratory in Concord. In addition, it is best to conduct chloride sampling in the spring as the snow is melting and during rain events.

➤ **Table 7a and Table 7b: Total Kjeldahl Nitrogen and Nitrite+Nitrate Nitrogen**

Table 7a in Appendix B presents the current year and historical Total Kjeldahl Nitrogen and Table 7b presents the current year and historical nitrite and nitrate nitrogen. Nitrogen is another nutrient that is essential for the growth of plants and algae. Nitrogen is typically the limiting nutrient in estuaries and coastal ecosystems. However, in freshwater, nitrogen is not typically the limiting nutrient. Therefore, nitrogen is not typically sampled through VLAP. However, if phosphorus concentrations in freshwater are elevated, then nitrogen loading may stimulate additional plant and algal growth. Please refer to the “Chemical Monitoring Parameters” section of this report for a more detailed explanation.

During the most recent DES Lake Assessment Program survey, which was conducted during Summer **1994**, the ratio of the total nitrogen concentration to total phosphorus (TN:TP) concentration in the **epilimnion** and **hypolimnion** samples collected at **each of the three deep spots** ranged from **5 to 16**.

Ratios **less than 15**, indicate that the lake is **nitrogen-limited**. This means that any additional **nitrogen** loading to the pond will stimulate additional plant and algal growth.

Ratios **greater than 15**, indicate that the lake is **phosphorus-limited**. This means that any additional **phosphorus** loading to the

pond will stimulate additional plant and algal growth.

Therefore, we recommend that the lake and its tributaries be sampled for nitrogen and phosphorus on a routine basis.

For more information regarding nitrogen sampling, contact the VLAP Coordinator.

➤ **Table 8: Total Phosphorus**

Table 8 in Appendix B presents the current year and historical total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The phosphorus concentration in the **tributaries** was **relatively low** this year, which is good news. However, we recommend that your monitoring group sample the major tributaries to the lake during snow-melt and periodically during rainstorms to determine if the phosphorus concentration is **elevated** in the tributaries during these times. Typically, the majority of nutrient loading to a lake occurs in the spring during snow-melt and during intense rainstorms that cause soil erosion and surface runoff and within the watershed.

For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report special topic article, which is posted on the VLAP website at http://www.des.nh.gov/wmb/vlap/2002/documents/Appndxd_monit_oring.pdf, or contact the VLAP Coordinator.

➤ **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**

Table 9 in Appendix B shows the dissolved oxygen/temperature profile(s) collected during **2006**. Table 10 in Appendix B shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The dissolved oxygen concentration was **greater than 100 percent** saturation at **0.1, 1.0, 2.0, 3.0, and 4.0** meters at the **Mohawk Island** deep spot on the **July** sampling event. Layers of algae can increase the dissolved oxygen concentration in the water column since oxygen is a by-product of photosynthesis. Wave action from wind can also dissolve atmospheric oxygen into the upper layers of

the water column.

The dissolved oxygen concentration was **relatively high** at all deep spot depths sampled at the **Three Island** and **Pot Island** deep spot on the **September** sampling event. As thermally stratified lakes age, and as the summer progresses, oxygen typically becomes **depleted** in the hypolimnion (lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological oxidation of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake where the water meets the sediment.

The dissolved oxygen concentration was **lower in the hypolimnion (lower layer) than in the epilimnion (upper layer)** at the **Mohawk Island** deep spot of the lake on the **July** sampling event. As stratified lakes age, and as the summer progresses, oxygen typically becomes **depleted** in the hypolimnion by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake where the water meets the sediment. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion (**as it has been during previous years at the Mohawk Island deep spot**), the phosphorus that is normally bound up in the sediment may be re-released into the water column (a process referred to as **internal phosphorus loading**). Since an internal source of phosphorus in the lake may be present in this location, it is even more important that watershed residents act proactively to minimize phosphorus loading from the watershed.

➤ **Table 11: Turbidity**

Table 11 in Appendix B lists the current year and historical data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the “Other Monitoring Parameters” section of this report for a more detailed explanation.

The tributary was **relatively low** this year, which is good news.

However, we recommend that your group sample the pond and any surface water runoff areas during significant rain events to determine if stormwater runoff contributes turbidity and phosphorus to the pond.

For a detailed explanation on how to conduct rain event sampling, please refer to the 2002 VLAP Annual Report special topic article, which is posted on the VLAP website at http://www.des.nh.gov/wmb/vlap/2002/documents/Appndxd_monitoring.pdf, or contact the VLAP Coordinator.

➤ **Table 12: Bacteria (*E.coli*)**

Table 12 in Appendix B lists the current year and historical data for bacteria (*E.coli*) testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **may** be present. If sewage is present in the water, potentially harmful disease-causing organisms **may** also be present.

Bacteria sampling was **not** conducted during **2006**. If residents are concerned about sources of bacteria such as failing septic systems, animal waste, or waterfowl waste, it is best to conduct *E. coli* testing when the water table is high, when beach use is heavy, or immediately after rain events.

➤ **Table 13: Chloride**

Table 13 in Appendix B lists the current year and the historical data for chloride sampling. The chloride ion (Cl⁻) is found naturally in some surfacewaters and groundwaters and in high concentrations in seawater. Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted **acute and chronic** chloride criteria of **860 and 230 mg/L** respectively. The chloride content in New Hampshire lakes is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. Please refer to the “Chemical Monitoring Parameters” section of this report for a more detailed explanation.

Chloride sampling was **not** conducted during **2006**.

➤ **Table 14: Current Year Biological and Chemical Raw Data**

Table 14 in Appendix B lists the most current sampling year results. Since the maximum, minimum, and annual mean values for each parameter are not shown on this table, this table displays the current year “raw,” meaning unprocessed, data. The results are sorted by station, depth, and then parameter.

➤ **Table 15: Station Table**

As of the spring of 2004, all historical and current year VLAP data are included in the DES Environmental Monitoring Database (EMD). To facilitate the transfer of VLAP data into the EMD, a new station identification system had to be developed. While volunteer monitoring groups can still use the sampling station names that they have used in the past and are most familiar with, an EMD station name also exists for each VLAP sampling location. Table 15 in Appendix B identifies what EMD station name corresponds to the station names you have used in the past and will continue to use in the future.

DATA QUALITY ASSURANCE AND CONTROL

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that this monitoring group did an **excellent** job when collecting samples and submitting them to the laboratory this season! Specifically, the proper field sampling procedures were followed and there was no need to rejected samples. Keep up the good work!

USEFUL RESOURCES

Acid Deposition Impacting New Hampshire's Ecosystems, DES fact sheet ARD-32, (603) 271-2975 or www.des.nh.gov/factsheets/ard/ard-32.htm.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, DES Booklet WD-03-42, (603) 271-2975.

Canada Geese Facts and Management Options, DES fact sheet BB-53, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-53.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, DES fact sheet WMB-10, (603) 271-2975 or www.des.nh.gov/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, DES fact sheet WD-SP-1, (603) 271-2975 or www.des.nh.gov/factsheets/sp/sp-1.htm.

Impacts of Development Upon Stormwater Runoff, DES fact sheet WD-WQE-7, (603) 271-2975 or www.des.nh.gov/factsheets/wqe/wqe-7.htm.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, DES fact sheet WD-BB-9, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-9.htm.

Low Impact Development Hydrologic Analysis. Manual prepared by Prince George's County, Maryland, Department of Environmental Resources. July 1999. To access this document, visit www.epa.gov/owow/nps/lid_hydr.pdf or call the EPA Water Resource Center at (202) 566-1736.

Low Impact Development: Taking Steps to Protect New Hampshire's Surface Waters, DES fact sheet WD-WMB-16, (603) 271-2975 or www.des.nh.gov/factsheets/wmb/wmb-17.htm.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, DES fact sheet WD-SP-2, (603) 271-2975 or www.des.nh.gov/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, DES fact sheet WD-WMB-4, (603) 271-2975 or www.des.nh.gov/factsheets/wmb/wmb-4.htm.

Sand Dumping - Beach Construction, DES fact sheet WD-BB-15, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-15.htm.

Shorelands Under the Jurisdiction of the Comprehensive Shoreland Protection Act, DES fact sheet SP-4, (603) 271-2975 or www.des.nh.gov/factsheets/sp/sp-4.htm.

Soil Erosion and Sediment Control on Construction Sites, DES fact sheet WQE-6, (603) 271-2975 or www.des.nh.gov/factsheets/wqe/wqe-6.htm.

Swimmers Itch, DES fact sheet WD-BB-2, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-2.htm.

Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants, DES fact sheet WD-BB-4, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-4.htm.

Watershed Districts and Ordinances, DES fact sheet WD-WMB-16, (603) 271-2975 or www.des.nh.gov/factsheets/wmb/wmb-16.htm.